Technical Report No. 8
1 October 1976 – 31 March 1977

Prepared by F. J. Mauk

High Gain Long Period Seismograph Station

Sponsored by

Advanced Research Projects Agency   (DOD)
ARPA Order No. 3291
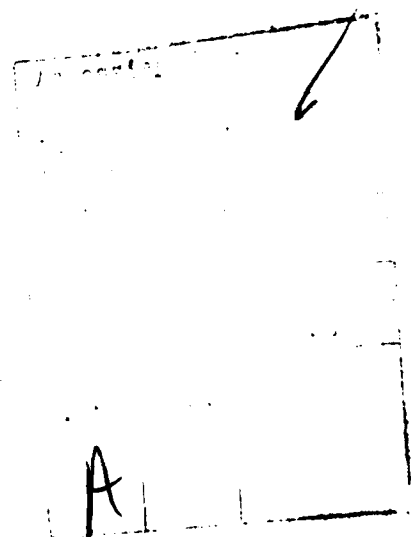Monitored by AFOSR Under Contract No. F44620-73-C-0060

JAN 1 8 1983

A

The views and conclusions contained in this document are
those of the author and should not be interpreted as
necessarily representing the official policies, either
expressed or implied, of the Defense Advanced Research
Projects Agency or the U. S. Government.

83   01   17   158

TABLE OF CONTENTS

Technical Report Summary
Contract No. F44620-73-C-0060

During this report period 1 October 1976 through 31
March 1977, the high gain seismograph station was partially
dismantled, and the recording equipment was moved to the
Seismological Observatory in Ann Arbor. The magnitude-
moment study by Barbara R. Williams is approximately 75%
completed. Similarly, the study of the characterization of
oceanic Rayleigh wave group velocities is nearing completion.
An abstract of a paper to be presented at the national meeting
of the AGU on the latter topic is appended.

The HGLP Station Status

In October of this report period, the surface recording
facility was dismantled and moved to the Seismological Obs-
ervatory in Ann Arbor. Since the U. S. Geological Survey
expressed interest in continued operation of the HGLP station
WPM, no attempt was made to remove the subsurface instal-
lation. The station will be reactivated in FY78 by the National
Earthquake Information Service branch of the U. S. Geological
Survey. The data will be telemetered from White Pine to
Ann Arbor, where it will be recorded on magnetic tape and
helicorders.

The Characterization of Oceanic Rayleigh Wave Group Velocity Dispersion by Tectonic Regionalization

Testing of the model for predicting Rayleigh wave group
velocity dispersion for paths through ocean basins (See Technical
Reports 6 and 7, Contract number F44620-73-C-0060) was
continued through this report period. The successful modeling
of Rayleigh wave group velocities for random paths across the
Pacific Ocean basins (Technical Report No. 7) was not realized
for the Atlantic Ocean Basins, nor the Indian Ocean Basin.
These oceanic regions display fundamental mode Rayleigh wave
group velocities which are frequently much faster than the
Pacific-based model can predict. The residuals of observed

-2-

minus predicted random path velocities were characteristically
greatest for the North Atlantic, intermediate for the South
Atlantic, and least for the Indian Ocean. This apparent
systematic deviation from the model is not a simple linear
shift of the group velocity versus age relationship reported in
Technical Report No. 6, figure 3 , however. A comparison of
velocities through crust and upper mantle Late Cretaceous age
sea floor in the Pacific and South Atlantic (Technical Report
No. 6, figure 2) suggested that the group velocities for periods
from 20 to 80 seconds were reasonably consistent for a given age
of sea floor. The dispersion curves did diverge at longer periods,
however. Because these higher velocities at periods greater than
80 seconds in the South Atlantic are more similar to shield
velocities than the predicted oceanic velocities, it was suggested that
the longer period waves had traversed the Brazilian Shield rather
than the Cretaceous age sea floor in transit from the Scotia Arc
to NAT. In light of additional data, however, this interpretation
is incorrect and the Atlantic equivalent-age sea floor is faster
than the Pacific. The velocity discrepancy between observed and
predicted dispersion becomes more significant for younger ocean
floor paths. This suggests that the crust and upper mantle be-
neath sea floor greater than eighty million years old is essentially
equivalent, regardless of the sea floor spreading rate or the
ridge axis thermal pulse which may influence the spreading rate.

There does appear to be a "memory" of the initial thermal event at depths greater than 150 kilometers in oceanic crust older than 80 million years, however, and this is reflected in the divergence of the fundamental mode Rayleigh group velocity dispersion curves at periods exceeding 80 seconds.

The observed-minus-predicted residuals in Rayleigh wave velocities for non-Pacific ocean basins appears to be a function of sea floor spreading rates and possibly variations of sub-lithosphere thermal flux. For example, the North Atlantic Basin with a present spreading rate of approximately 1 cm/yr has much higher equivalent-age crust and upper mantle velocities than does the model which is based on a mean spreading rate greater than 4 cm/yr. Thus, although the end points of the group velocity versus age functions may be nearly identical for all ocean basins, the functions between these constraints may be widely different, depending on the individual spreading rates. Since it is relatively difficult to obtain "pure path" observations in relatively slow spreading ocean basins, this problem would be best modeled in a different manner than the initial empirical model.
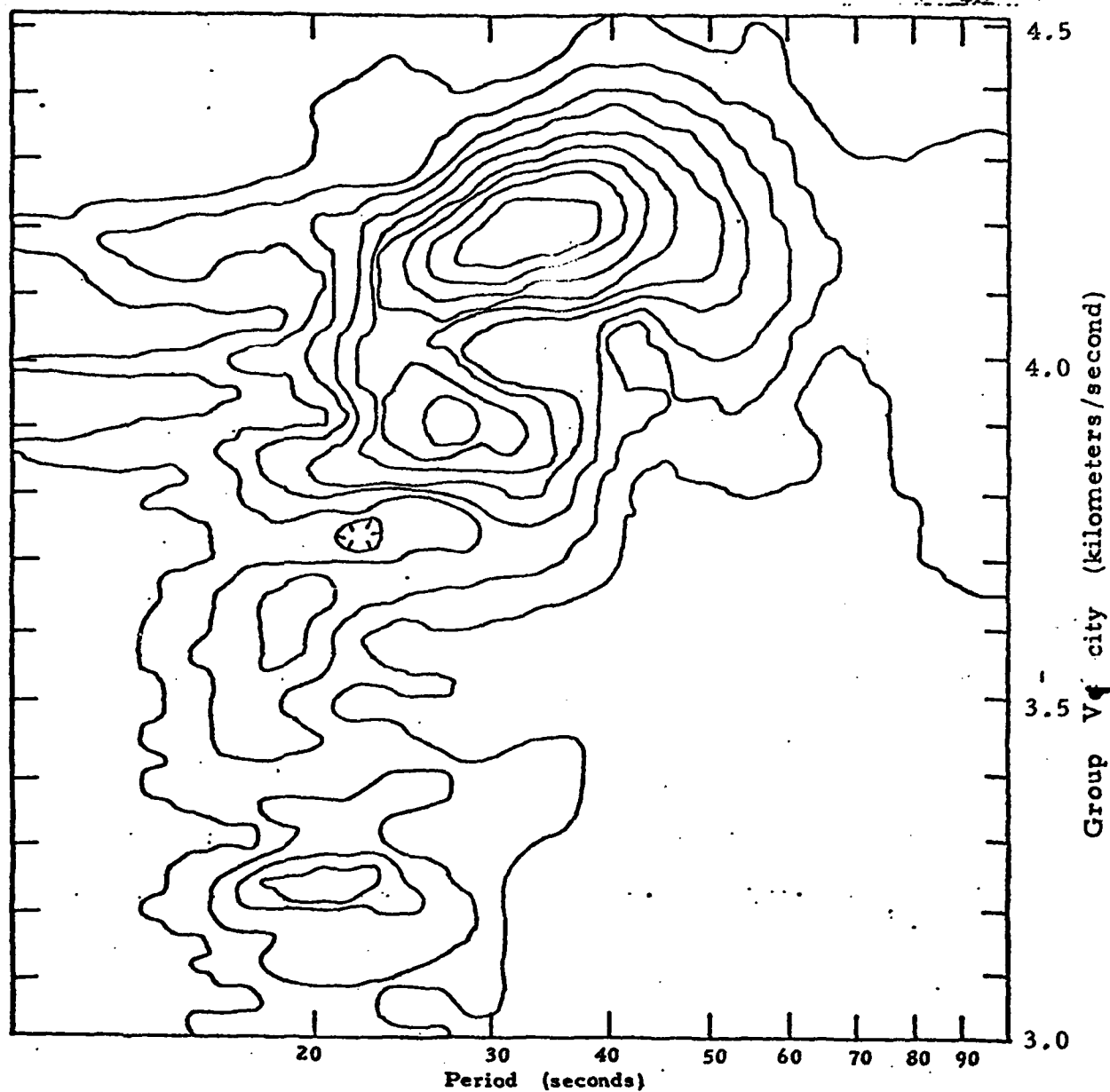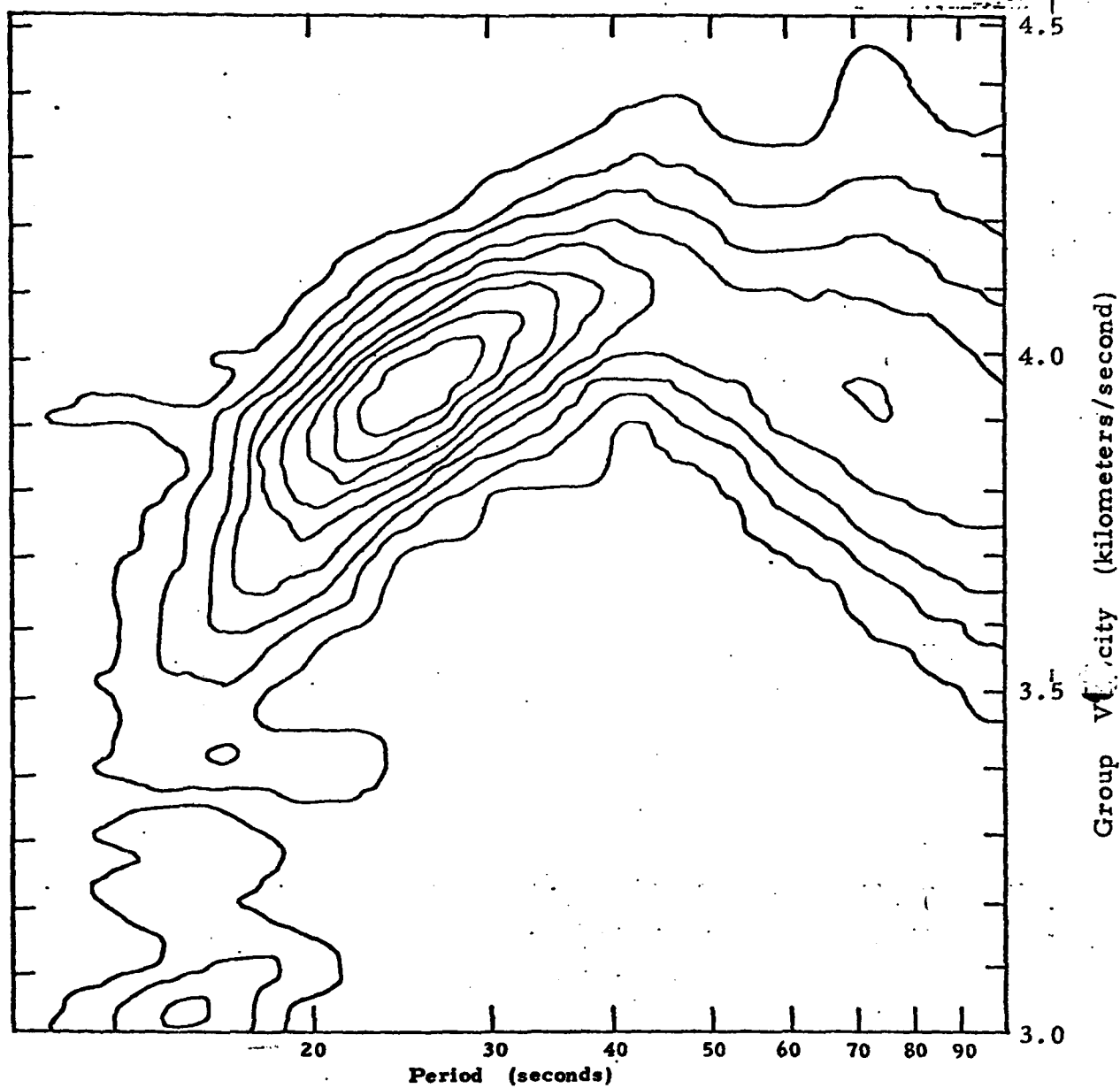
North Atlantic Ocean Earthquake June 12, 1974 16:25:47.6, 10.56 N
63.38 W Recording Station TLO Epicentral distance 6653.0 kilo-
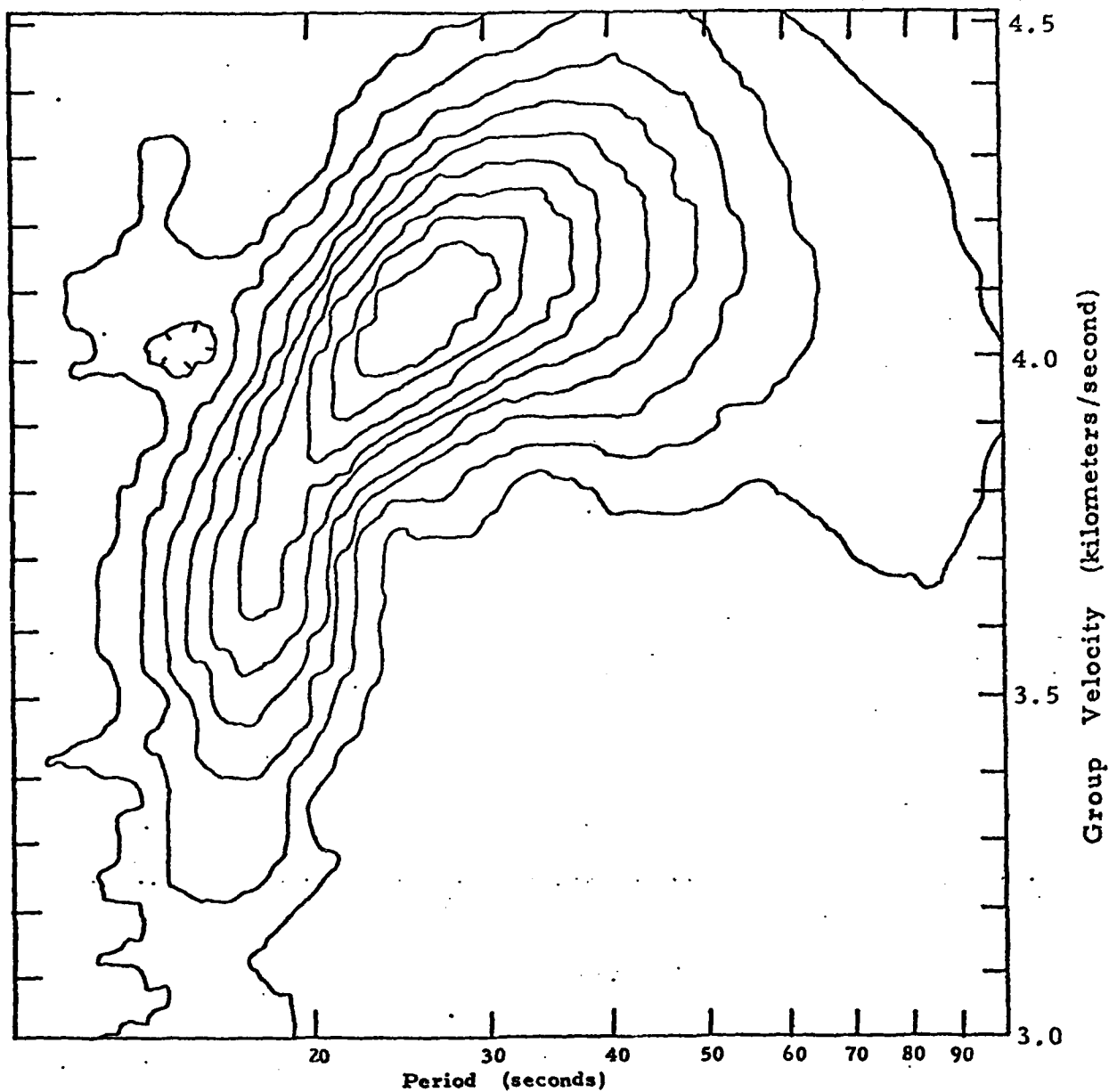meters.

Figure 1
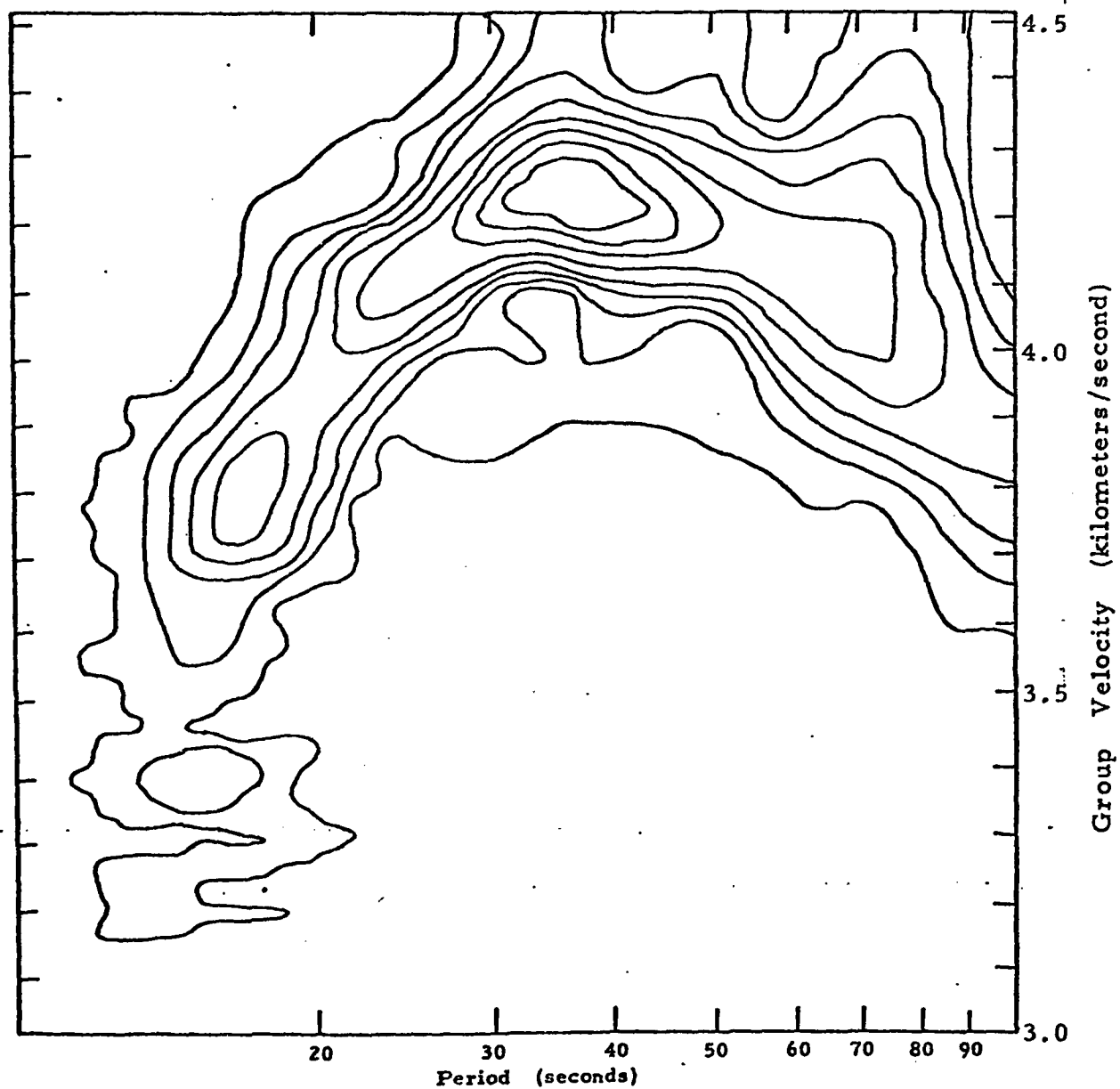
North Atlantic Ocean Earthquake August 5, 1971 01:58:53.2, 00.85 S
22.07 W Recording Station AKU Epicentral distance 7383.9 kilo-
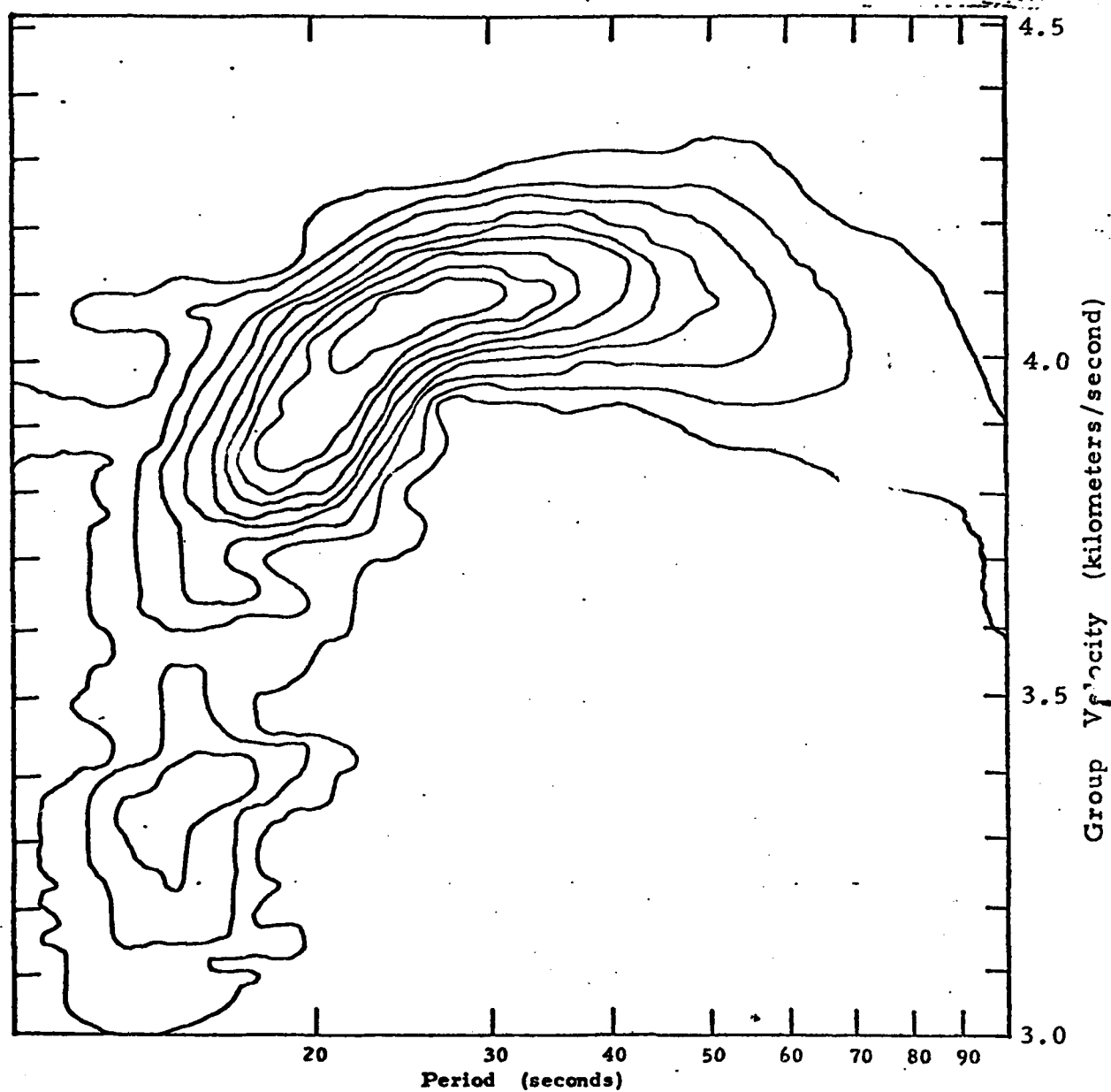meters.

Figure 2

South Atlantic Ocean Earthquake April 7, 1973 12:22:49.3, 58.5 S
,13.6 W Recording Station SDB Epicentral distance 5307.0 kilometers.
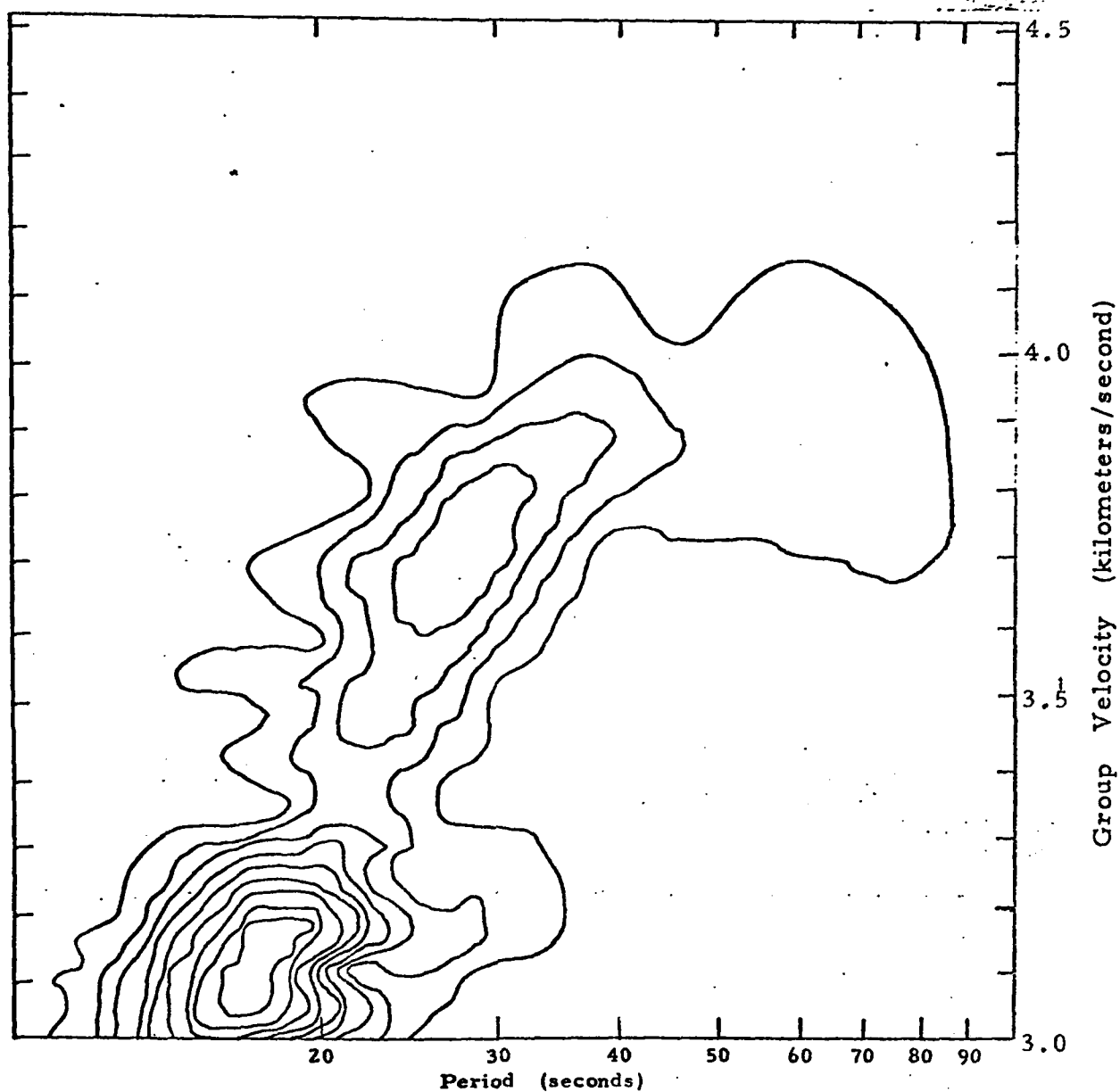
Figure 3

-7-

Indian Ocean Earthquake June 25, 1974 17:22:19.3, 26.1 S 84.3 E
Recording Station LEM Epicentral distance 3261.0 kilometers.

Figure 4

Indian Ocean   Earthquake June 11, 1973 07:22:57.5, 47.92 S 99.69 E
Recording Station   KOD   Epicentral distance 6796.1 kilometers.

Figure 5

Arctic Ocean Earthquake January 28, 1967 17:42:01.5, 52.4C N
169.41 W Recording Station NOR Epicentral distance 5044.9 kilo-
meters.

Figure 6

-10-

PREDICTION OF OCEANIC RAYLEIGH WAVE GROUP VELOCITIES: ONE HIT AND SEVERAL NEAR MISSES

Frederick J. Mauk (University of Michigan, Department of Geology and Mineralogy, Ann Arbor, Michigan 48109)

A fundamental mode oceanic Rayleigh wave group velocity predictor based on sea floor age has been described by Mauk (EOS, vol 50, no. 10, 1976). Application of this empirical model to random paths across the Pacific basins yield group velocity residuals for periods from 30 to 100 seconds which are consistently less than 0.02 km/sec. Similar random path tests of the Pacific-derived model have been conducted for the North Atlantic, South Atlantic and Indian Oceans. Observed group velocities for these three ocean basins were consistently faster, frequently greater than 0.20 km/sec, than predicted by the model. The largest residuals occurred in the North Atlantic Ocean, the smallest in the Indian Ocean. This suggests that models of Rayleigh group velocities based solely on sea floor age are incomplete. The additional requisite model correction to predict accurately the group velocities for all ocean basins appears to be embodied in the spreading rates. Since the functional relationship between group velocities and sea floor age appears to be related to the thermal evolution of the oceanic lithosphere, the observed velocity variations among these ocean basins suggests that the mantle heat flow into the base of the lithosphere is non-uniform.